Queen's Economics Department Working Paper No. 93

A DEVALUATION MODEL FOR A SMALL OPEN ECONOMY

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10-1972

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DISCUSSION PAPER NO. 93

October, 1972

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In her recent survey of balance-of-payments theory, Krueger [2] laments the fact that despite a number of promising lines of inquiry several crucial issues have not been resolved in dealing with the total impact of devaluation. She notes some of these: "The role of home goods is as yet imperfectly understood. Even though money is now incorporated explicitly in most payments models, the monetary theory used is years behind current monetary theory. Little use is made of portfolio analysis and the theory of choice." [2, p. 22] While an advance on all these fronts in a generalized model may still be too complex, the purpose of this paper is to develop a devaluation model for a small open economy that incorporates the crucial features of non-traded goods, money and the requirements of portfolio equilibrium.

The point of departure for a devaluation model of a small open economy is the assumption made concerning the terms of trade. In a standard devaluation model, the terms of trade are allowed to vary when a change in the exchange rate takes place. Normally, the terms of trade will improve after a devaluation if the product of the supply elasticities of exports and imports is greater than the product of the demand elasticities. For a small open economy which is assumed to be a price taker in world markets, the world prices of exportables and importables[1] are fixed and a devaluation

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1. Exportables are defined as exports plus domestic consumption of exportables. Importables are defined as imports plus domestic production of importables.

will increase the domestic price of both by the extent of the devaluation. Hence the terms of trade, in both the domestic and foreign currencies remain unchanged and it is appropriate to aggregate exportables and importables into one category, tradables. The effect of devaluation will then be on the relative price of tradables and non-tradables.

Until recently the major focus of devaluation models has been on the effect of a change in the exchange rate on the trade balance. However, the introduction of portfolio analysis into balance-of-payments theory has rendered nugatory the emphasis on stability conditions in the foreign exchange market. Once portfolio or wealth adjustments are taken into account, a devaluation cannot lead to a continuing surplus in the balance of payments or the trade balance. Static equilibrium in these models requires that all asset demands are satisfied which implies that capital flows are reduced to zero and that wealth not be increasing or decreasing which in turn requires the trade balance to be zero. In a growing economy, these constraints no longer apply since the acquisition of new assets may be from domestic or foreign sources. In the latter case, capital flows are consistent with equilibrium. But even in a growing economy it is not clear that the traditional role of the exchange rate is resurrected. Assume that wealth in the home country is growing at a faster rate than abroad. This leads to capital outflows as well as to a trade deficit. A devaluation may temporarily reduce this deficit but in the long run the growth of the economy will re-assert itself and the balance of payments will again move along its original path.

Nevertheless the exchange rate still has an important role to play, particularly for small open economies. As will be shown in this paper, the

exchange rate influences the price level and aggregate output and therefore it can become a tool of stabilization policy especially if monetary and fiscal policies are unavailable for this purpose.

I. The Model

In order to treat devaluation in a general equilibrium framework it is necessary to specify equilibrium conditions in four markets: tradables, non-tradables, money and bonds. In the model to be developed below unemployed resources are assumed to exist, but in the next section, the required changes in the analysis when full employment is assumed will be indicated.

1. The Market for Tradables

Once exportables and importables are lumped together the trade balance is defined as domestic output of tradables minus domestic absorption of tradables.[1] But as we have seen, a non-zero trade balance is not consistent with static equilibrium since it implies an accumulation or decumulation of wealth. Thus in the tradable sector domestic demand must equal domestic output. This requirement can be specified in the following equation:

$$(1) \qquad A_t (p_t, p_n, Y) - Q_t (p_t) = 0,$$

where A_t = domestic absorption of tradables, Q_t = domestic output of tradables, p_t, p_n = domestic price of tradables and non-tradables, set initially equal to 1 by an appropriate choice of quantity units and Y = money GNP. The demand function A_t ( ) is homogenous of degree zero with

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1. This is similar to Alexander's B = Y-A [1].

respect to prices and income. The supply function Q_t ( ) allows for unemployed resources but $Q_t' > 0$ on the basis that an expansion of output draws in resources which are less productive than intra marginal units but wages are rigid. This supply function will be replaced by one which maintains full employment in the next section of the paper. In addition, it may be noted that the price of tradables is fixed in both the domestic currency and in any numeraire currency as long as the exchange rate is held constant. A devaluation will raise the domestic price of tradables by the extent of the devaluation but the small-country assumption ensures that the world price remains unchanged.

2. The Market for Non-Tradables

In this sector, domestic demand is also equal to domestic output in equilibrium. Hence an analogous equation to (1) can be specified.

$$(2) \qquad A_n (p_t, p_n, Y) - Q_n (p_n) = 0,$$

where A_n = domestic absorption of non-tradables and Q_n = domestic output of non-tradables.

3. The Money Market

For a small open economy with perfect capital mobility sterilization operations are fruitless. Hence any change in the holdings of reserves directly affect the money supply. The following equation, taken from Mundell [4] describes equilibrium in the money market.

$$L(Y) - D - R = 0,$$

where $L(Y)$ = demand for nominal money balances, D = domestic component of the money supply and R = level of international reserves. We will assume "orthodox neutral" monetary policy[1] which requires that the central bank not engage in open market operations (i.e. $dD = 0$). Thus any increase in the demand for money must be satisfied by an increase in the level of reserves. But by the same token, a continuous deficit or surplus in the balance of payments would require continuous changes in real income or prices which is not consistent with static equilibrium. Thus devaluation, while it can change the level of reserves once and for all, is unable to bring about a lasting surplus or deficit in the balance of payments. It should also be noted that the interest rate does not appear as an argument in the demand function for money. The reason for this procedure derives from Mundell's proof [4] that for a small open economy with perfect capital mobility the domestic interest rate cannot deviate from the world interest rate.

4. The Bond Market

The bond market is a crucial ingredient in a balance-of-payments model since domestic purchases of foreign bonds or foreign purchases of domestic bonds represent balance-of-payments transactions. However it is not necessary to specify a separate equilibrium condition for the bond market since the requirement that both the trade balance and the balance of payments be zero in equilibrium ensures that there will be no capital flows and that all domestic asset demands are satisfied.[2]

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1. As defined by Tsiang [8].

2. It is assumed that the government does not have a budget deficit which would require new issues of bonds and hence adjustments in domestic portfolios.

However the assumption of perfect capital mobility in a devaluation model requires some comments. In a situation of fixed exchange rates, domestic and foreign bonds can be assumed to be perfect substitutes and their prices and interest rates will be equalized. In the case of the small open economy, the domestic interest rate adjusts to the world interest rate. Flexible exchange rates or policy-determined changes in the exchange rate, on the other hand, will render the perfect substitutability of the two types of bonds in doubt. In particular, a devaluation of the domestic currency results in a capital loss to foreigners holding domestic bonds. Thus, if the devaluation is anticipated foreign holders will attempt to rid themselves of domestic bonds in order to prevent such a capital loss. In addition, domestic wealth holders will experience capital gains on their holdings of foreign bonds. For both these reasons the price of domestic bonds will be lowered and the price of foreign bonds will be increased resulting in an interest differential between the two bonds. Also the changes in wealth caused by the devaluation will influence the current account through wealth-induced changes in expenditures on tradables and non-tradables.

In order to maintain the assumption of perfect capital mobility and thus to simplify the analysis, the following assumptions will be made:

(a) Domestic residents do not hold foreign bonds. Thus a devaluation will not change the value of domestic wealth.

(b) Devaluations are not anticipated. Hence there will be no speculative capital flows.

(c) The change in foreign wealth caused by the devaluation will not alter future holdings of domestic bonds nor foreign expenditures. Since the rest of the world is large, foreign

holdings of domestic bonds will be a small proportion of total foreign wealth and any change in the value of this component can be considered inconsequential.

II. The Effects of Devaluation

Equations (1), (2) and (3) describe the equilibrium conditions in the tradable, non-tradable and money markets. In addition, equilibrium is assured in the bond market by the requirement in equation (1) that the trade balance be zero and by the requirement in equation (3) that the balance of payments be zero. Thus by Walras Law, equation (2) can be eliminated and equilibrium in the non-tradable market determined residually.

However, three identities are required to close the model.

$$Y = p_t Q_t + p_n Q_n, \tag{4}$$

$$p = \frac{p_t Q_t}{Y} p_t + \frac{p_n Q_n}{Y} p_n, \tag{5}$$

$$y = Y/p, \tag{6}$$

where y = real income and p = aggregate price level.[1] Equation (4) is an income output identity, equation (5) defines the price level as a weighted average of the prices in the two sectors with fixed value-of-production weights and equation (6) relates real income to nominal income and the price level.

By appropriate substitution and differentiating the resulting system we obtain

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1. Initially $p_t = p_n = 1$, therefore $p = 1$ and $Y = y$.

$$(7)\quad dp_t\,(A'_{t,p_t} - Q'_{t,p_t} + A'_{t,Y}Q_t) + dp_n\,(A'_{t,p_n} + A'_{t,Y}Q_n) + dy\,(A'_{t,Y}) = 0,$$

$$(8)\quad dp_t\,(L'_YQ_t) + dp_n\,(L'_YQ_n) + dy\,(L'_Y) - dR = 0,$$

$$(9)\quad dp_t\,(Q'_{t,p_t}) + dp_n\,(Q'_{n,p_n}) - dy = 0,$$

where $A'_{t,p_t} = \partial A_t/\partial p_t$, etc.

Let $\beta_1 = A'_{t,p_t} - Q'_{t,p_t} + A'_{t,Y}\,Q_t = E_{A_t,p_t}\,Q_t - E_{Q_t,p_t}\,Q_t + E_{A_t,Y}\,\frac{Q_t^2}{Y}$,

where E_{A_t,p_t} refers to the elasticity of A_t with respect to p_t, etc. From the assumption of zero degree homogeneity in the demand function

$$E_{A_t,p_t} = -\,E_{A_t,p_n} - E_{A_t,Y}\ ^1$$

which can be substituted in the above expression whence

$$\beta_1 = Q_t[-\,E_{A_t,p_n} - E_{Q_t,p_t} + E_{A_t,Y}\ (\frac{p_tQ_t}{Y} - 1)] < 0$$

since $p_tQ_t/Y < 1$. All other parameters are positive and assumed constant for small changes in the variables. For simplicity let $\lambda_1 = A'_{t,p_n} + A'_{t,Y}Q_n > 0$.

The exogenous policy variable is dp_t which represents the percentage change in the exchange rate if the world price of tradables in a numeraire currency remains fixed. This leaves the following variables to be determined: dp_n, dy and dR. Hence we can calculate the effect of a devaluation on the price level, output, and the level of reserves.

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1. See Pearce [6 p. 88].

Equations (7), (8) and (9) can be written in matrix form.

$$\begin{bmatrix} \lambda_1 & A'_{t,Y} & 0 \\ L'_Y Q_n & L'_Y & -1 \\ Q'_{n,p_n} & -1 & 0 \end{bmatrix} \begin{bmatrix} dp_n \\ dy \\ dR \end{bmatrix} = \begin{bmatrix} -\beta_1 dp_t \\ -L'_Y Q_t dp_t \\ -Q'_{t,p_t} dp_t \end{bmatrix}$$

Let Δ be the determinant of the system,

$$\Delta = -\lambda_1 - A'_{t,Y} Q'_{n,p_n} < 0.$$

The effect of a devaluation ($dp_t > 0$) on the price of non-tradables can be calculated as follows:

$$(10) \quad \frac{dp_n}{dp_t} = \frac{1}{\Delta}\left[\beta_1 + A'_{t,Y} Q'_{t,p_t}\right] = \frac{Q_t}{\Delta}\left[-E_{A_t,p_n} - E_{Q_t,p_t}(1-A'_{t,Y}) + E_{A_t,Y}\left(\frac{p_t Q_t}{Y} - 1\right)\right] > 0.$$

With an exogenous increase in the domestic price of tradables, domestic absorption switches from tradables to non-tradables. To re-establish equilibrium in both markets, the price of non-tradables must rise, if tradables and non-tradables are substitutes. In general it is not possible to determine whether the price of non-tradables will rise more or less than the price of tradables, but if $dp_n/dp_t = 1$, there will be no change in relative prices. This situation would occur if we assume $E_{A_t,Y} = 1$ and $E_{Q_t,p_t} = E_{Q_n,p_n}$.

The effect of devaluation on the price of non-tradables has an important impact on McKinnon's optimum currency area argument [3]. In his analysis, domestic price stability is an important objective. A devaluation

which increases the price of tradables will also increase the overall price index depending on the size of the tradable sector. However, by assumption, "The price of non-tradable goods... is kept constant in terms of the domestic currency."[3, p. 719] Thus

$$(11) \qquad \frac{dp}{dp_t} = \alpha,$$

where $\alpha = p_t Q_t / Y$ and indicates the relative size of the tradable sector. The larger is α the greater is the effect on the price level of a given devaluation. He thus concludes that a currency area with a "large" tradable sector is not an optimum currency area since it would sacrifice the objective of price stability. However by assuming that $dp_n/dp_t = 0$, a second dimension of the problem has been neglected. The effect of devaluation on the price level is dependent on both the size of the tradable sector and the change in the price of non-tradables brought about by devaluation. In terms of the model of this paper, the effect of devaluation for the price level can be measured by

$$(12) \qquad \frac{dp}{dp_t} = \alpha + (1-\alpha)\frac{dp_n}{dp_t} = \alpha\left(1 - \frac{dp_n}{dp_t}\right) + \frac{dp_n}{dp_t}.$$

Let Ω be the measure of price stability ($\Omega = dp/dp_t$). Then differentiating (12) with respect to α,

$$\frac{\partial \Omega}{\partial \alpha} = 1 - \frac{dp_n}{dp_t}$$

and it is no longer clear that a decrease in the size of the tradable sector will result in greater price stability. This will only occur if $dp_n/dp_t < 1$. In general, McKinnon underestimates the impact of devaluation on price stability by arbitrarily holding constant the price of

non-tradables.[1]

We can now analyze devaluation as a stabilization policy instrument by determining its effect on real income or output.

$$(13) \qquad \frac{dy}{dp_t} = \frac{1}{\Delta}\left[-\lambda_1 Q'_{t,p_t} + \beta_1 Q'_{n,p_n}\right] > 0.$$

Since the prices of both tradables and non-tradables have risen, the output of each will also increase and real income rises. Normally devaluation is eschewed as a policy instrument to increase aggregate demand since it is a beggar-my-neighbour policy and invites retaliation. This arises from the fact that in the standard devaluation analysis the increase in aggregate demand involves an improvement in the trade balance which must be equal to the decline in the trade balance of other countries and hence results in a reduction in foreign aggregate demand. But devaluation by a small open economy does not have this stigma attached since before and after the devaluation the trade balance is zero and if devaluation increases exports then imports will also increase. In this light, devaluation is a legitimate policy instrument, particularly if monetary and fiscal policies are partially or completely inoperative. Nevertheless, it is unlikely that an economy can be "fine tuned" through this mechanism for if the exchange rate is adjusted frequently and in response to deviations of the level of aggregate demand from some target level, speculators will come to anticipate these changes giving rise to speculative capital flows which may exacerbate the problem of stabilization.

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1. One way of justifying McKinnon's assumption that $dp_n/dp_t = 0$ is to postulate an infinite supply elasticity in the non-tradable sector but this would imply $\Delta = -\infty$ and devaluation will not affect any of the variables in the system.

If devaluation is used as a stabilization instrument then it essentually substitutes for open market operations. Although devaluation cannot bring about a continuous improvement in the balance of payments it can cause a once-and-for-all change in the level of reserves and thus an equal change in the domestic money supply because of the impossibility of sterilization operations.[1] The change in the level of reserves caused by a devaluation can be calculated as follows:

$$(14) \quad \frac{dR}{dp_t} = \frac{L'_Y}{\Delta} \left[\lambda_1(-Q'_{t,p_t} - Q_t) - Q_n\,(-A'_{t,Y}\,Q'_{t,p_t} - \beta_1) + Q'_{n,p_n}(-A'_{t,Y}Q_t + \beta_1)\right] > 0,$$

since the term in the second parentheses can be shown to be positive from equation (10). Thus devaluation increases the level of reserves and the money supply necessary to meet the higher demand for money caused by a higher level of real income and an increase in the price level. This is consistent with the proposition made by Mundell [5].

III. Devaluation at Full Employment

The effect of a devaluation depends importantly on whether the economy is operating at less than full employment or full employment. In the previous section the former situation was assumed. With full employment, the economy moves along the production possibility curve so that the expansion of output in one sector is at the expense of output in the other sector. This requires a change in the supply functions to

$$(15) \quad Q_t = Q_t\,(p_t/p_n),$$

and

$$(16) \quad Q_n = Q_n\,(p_t/p_n),$$

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1. The effect of the reserve position on the money supply is discussed in [4] and [7].

where $Q_t' > 0$ and $Q_n' < 0$. Substituting (15) and (16) into (4) and using (5) and (6) it can be shown that $dy = 0$. Thus devaluation will not be able to change real income. Substituting (15) into (1) and differentiating the equilibrium conditions for the tradable sector and the money market yields

$$(17) \quad dp_t \, (A'_{t,p_t} - Q_t' + A'_{t,Y}Q_t) + dp_n \, (A'_{t,p_n} + Q_t' + A'_{t,Y}Q_n) = 0,$$

$$(18) \quad dp_t \, (L'_Y Q_t) + dp_n \, (L'_Y Q_n) - dR = 0.$$

Let $\beta_2 = A'_{t,p_t} - Q_t' + A'_{t,Y}Q_t = Q_t[-E_{A_t,p_n} - E_{Q_t,p_t/p_n} + E_{A_t,Y}(\frac{p_t Q_t}{Y} - 1)] < 0$

and $\lambda_2 = A'_{t,p_n} + Q_t' + A'_{t,Y}Q_n = \lambda_1 + Q_t' > 0.$

In general we cannot compare β_1 and β_2.

Writing (17) and (18) in matrix form

$$\begin{bmatrix} \lambda_2 & 0 \\ L'_Y Q_n & -1 \end{bmatrix} \begin{bmatrix} dp_n \\ dR \end{bmatrix} = \begin{bmatrix} -\beta_2 dp_t \\ -L'_Y Q_t dp_t \end{bmatrix}$$

We can solve for the remaining endogenous variables in the system. Let Δ' be the determinant.

$$\Delta' = -\lambda_2 < 0$$

Therefore

$$(19) \quad \frac{dp_n}{dp_t} = -\frac{\beta_2}{\Delta'} = -\frac{\beta_2}{\lambda_2}.$$

In comparing (19) and (10) we should expect a smaller price increase in the non-tradable sector under full employment. Since with less than full employment a devaluation causes an increase in the demand for non-tradables

for two reasons: an increase in the price of tradables and an increase in income. With full employment only the former cause is operative. Thus, in general, a devaluation at full employment will increase the price level less than a devaluation with unemployed resources.

We can also solve for the change in reserves.

$$(20) \quad \frac{dR}{dp_t} = \frac{L'Y}{\lambda_2} \left[\lambda_2 Q_t - \beta_1 Q_n\right] > 0.$$

The level of reserves will increase as a result of devaluation, but since only prices increase the demand for money will increase less than if both prices and income rise which occurs at less than full employment.

IV. Conclusions

While the focus of devaluation has been shifted from its impact on the trade balance to its effects on such variables as the price level, output and the money supply, the framework for the analysis has followed the pattern suggested by Krueger. Nevertheless the model has its pit-falls. It is rendered in static equilibrium terms, leaving out of account such important considerations as expectations and dynamic adjustment paths.

Moreover it is not suggested that an adjustable-peg system of exchange rates is an optimum strategy for small open economies. In a separate paper [7] I have shown that a flexible exchange rate together with an appropriate combination of monetary and fiscal policies will allow the economy to expand output while maintaining a constant price level, whereas devaluation by itself increases output and the price level forcing the authorities to choose a point on a trade-off curve similar to the Phillips curve.

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